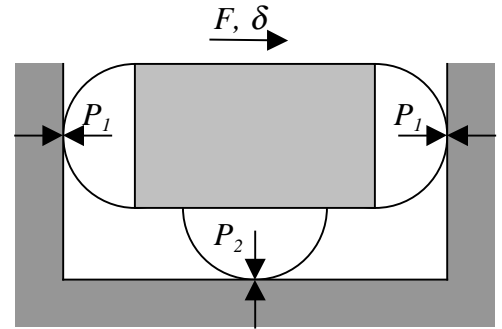


# PREDICTABLE INTERFACE CONFIGURATIONS FOR FRICTION DAMPERS: DESIGN AND EXPERIMENTAL VALIDATION

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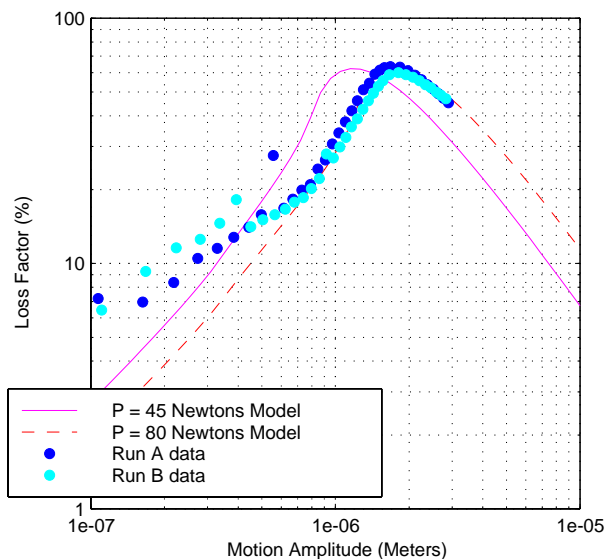
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Cryogenic operating temperatures and submicron vibration levels have motivated the development of a friction damper for future space-based optical instruments. A mechanism design methodology employing nonconforming contact mechanics and microslip dissipation to meet these requirements will be presented. One interface architecture, shown to the right, was selected for providing high damping levels at small displacement amplitudes as well as high stiffness for larger motion. A prototype damping component based on this design has been fabricated and studied to validate the modeling approach. The presentation will describe both the analytical and experimental aspects of this study.



Modeling of the component employs both Hertzian contact mechanics and Mindlin's analyses of microslip [1,2]. While microslip has been employed in friction dampers in the past, the use of Hertzian contact to provide a nonlinear restoring force appears to be a novel design approach [3,4]. Comparisons of the predicted and measured behavior indicate that the amplitude-dependent dissipation of the prototype is well represented by this approach. The figure below illustrates the predicted and observed dissipation levels in the micron range. Increased compliance in the observed behavior below 0.5 microns may be indicative of contributions of surface roughness mechanics which were not included in the model. Such contributions would provide both the increased dissipation and compliance which was observed.

While such nonlinear contact mechanics have proven difficult to model in other mechanisms with less deterministic interface load paths, this study has indicated that careful design can enable accurate modeling of strongly nonlinear elastic and microslip dominated mechanisms. As a result, the design of a number of optical precision mechanisms is building on this modeling approach.



## References

- [1] Mindlin, R.D., "Compliance of Elastic Bodies in Contact," *J. Appl. Mech., Trans. ASME*, Vol. 71, p. 259, 1949.
- [2] Johnson, K.L., "Energy Dissipation at Spherical Surfaces in Contact Transmitting Oscillating Forces," *J. Mech. Eng. Sci.*, Vol. 3, No. 4, p. 362-368, 1961.
- [3] Wettergren, H.L., "Optimal Design to Reduce Dynamic Instability of a Turbine Generator Due to Microslip," *J. of Sound and Vibration*, Vol. 214, No. 1, p. 57-66, 1998.
- [4] Csaba, G., "Forced Response Analysis in Time and Frequency Domains of a Tuned Bladed Disk with Friction Dampers," *J. of Sound and Vibration*, Vol. 214, No. 3, p. 395-412, 1998.